1. An ideal gas at 1 atm, 25°C is compressed adiabatically to 6 atm. Assuming that the process is a reversible adiabatic process and the isentropic exponent is 1.23. Calculate (a) the temperature, (b) the work done on the system, (c) the heat transferred to surroundings, (d) the change in internal energy, and (e) the change in enthalpy.
(15%)

2. For the reaction
$$2CO + O_2 = 2CO_2$$
at 25°C, 1 atm. Calculate
(a) the standard enthalpy change of the reaction,
(b) the standard entropy change of the reaction,
(c) the maximum work,
(d) the heat transferred to surroundings if no work is done,
(e) the heat transferred to surroundings if maximum work is done.

Given: $\Delta H^\circ_{298,CO} = -110.46$ KJ.mol^{-1}

$\Delta H^\circ_{298,CO_2} = -393.30$ KJ.mol^{-1}

$S^\circ_{298,CO} = 198$ J.K^{-1}.mol^{-1}

$S^\circ_{298,CO_2} = 214$ J.K^{-1}.mol^{-1}

$S^\circ_{298,O_2} = 205$ J.K^{-1}.mol^{-1}

(15%)

3. Explain the difference between the dry bulb temperature and the wet bulb temperature. How are measurements of each obtained? If the wet bulb temperature, the dry bulb temperature, and the barometric pressure are known, can you obtain the relative humidity? If so, by what means can this be done?
(10%)

4. Calculate the equilibrium constant for the reaction
$$NiO_{(s)} + H_{2(g)} = Ni_{(s)} + H_2O_{(g)}$$
at 750°C.
Given:

$Ni_{(s)} + \frac{1}{2}O_{2(g)} = NiO_{(s)}$ $\Delta G^\circ = -222,555 + 98.53T$ J

$H_{2(g)} + \frac{1}{2}O_{2(g)} = H_2O_{(g)}$ $\Delta G^\circ = -246,438 + 54.81T$ J

(10%)

5. Two reversible heat engines work at different conditions but with the same efficiency. The first one operates reversibly at temperatures between 700°C and 200°C, while the second one absorbs 2000 J of heat from a high temperature reservior at 1000 K. Calculate (a) the efficiency of the heat engines, (b) the work the second engine must accomplish, and (c) the temperature at which the second engine releases heat.
(12%)

6. The equilibrium constant of the reaction A + B = C is 10^{-5} at 1000 K. What is ΔG at 1000 K when the activities of A, B, and C are 0.5, 0.5, and 0.3, respectively?
(5%)

7. At 1200 K, $\Delta G^\circ_{MoO_2} = -374320$ J/mole and $\Delta G^\circ_{H_2O} = -226120$ J/mole. In what composition of H_2/H_2O gases will MoO_2 be reduced to Mo at 1200 K?
(5%)

8. Calculate the work done by the system for mercury when the the external pressure is changed from 0 to 10^7 Kg/m^2. Calculate also the heat flow out of the system as well as the change in internal energy.
Given:
the thermal expansion coefficient $\alpha = 1.47 \times 10^{-5}$ m^3/mole;
the compressibility $\beta = 3.84 \times 10^{-11}$ m^2/N.
(16%)

9. (a) Using three equations to describe the state of total equilibrium of a system.
(b) Give a general equation, in differential form, to illustrate the principle of energy conservation.
(c) Give an example showing the irreversible reaction.
(12%)